MAC - A Summary of Critical Decisions

This document has been created and reviewed by the A2LA Measurement Advisory Committee (MAC). It provides a summary of consensus decisions voted on and approved by the Measurement Advisory Committee and A2LA Criteria Council for use by laboratories and assessors. Dates in parentheses after each item indicate the date each was approved by the A2LA Criteria Council.

I. General

a. A2LA treats statements of conformance and uncertainty as a contract review issue. (1/13/11) (see Tab 1 for summary minutes)

b. Decision rules do not need to be provided on a calibration certificate if the provider (OEM) states the measured value, the uncertainty, and that it is within specifications. (1/13/11) (see Tab 1 for summary minutes)

c. It is never acceptable to accept manufacturer's specifications in lieu of uncertainty budget calculations. (1/13/11)

d. The acceptability of a single point calibration is determined on a case-by-case basis by the technical assessor. (1/13/11)

II. Gage Blocks

a. For cases where a gage block is damaged it is agreed that there is no "before" data available and the "as found" information is stated on the certificate. An A2LA assessor would not expect to see before data on a certificate if the received condition says damaged or in need of repair/replacement. (1/13/11)

III. Fluke 50 Turn Coils

a. For Fluke coils (5500A/coil, 52120A/coil 3KA, 52120A/coil 6KA) purchased after March 20, 2015 the traceability requirements must comply with A2LA P102 as an accredited calibration service is available. As per the previous MAC decision an open ended calibration interval is acceptable supported with visual checks. (6/4/2015).

b. For Fluke Coils an open-ended calibration interval is acceptable as further calibrations would not be needed, only visual checks. (1/13/11) (see Tab 2 for summary minutes)

c. A Conformance Assessment Body (CAB) can elect to meet (T4) from *P102 – A2LA Metrological Traceability Policy* in lieu of a calibration certificate for Fluke 50 turn

coils. The in-house calibration must be limited to the range from the initial original calibration certificate for the coil. The initial calibration certificate must pre-date the reverse traceability information provided from Fluke.
(1/13/11 – amended 6/4/2015) (see Tab 2 for summary minutes)

IV. Hardness

a. The minimum factors required for hardness uncertainty budgets are repeatability, resolution, and the uncertainty of the block. (1/13/11)

Note: this is applicable for hardness uncertainty budgets developed prior to January 1, 2012. (1/13/11 - amended 6/4/13).

V. Surface Plate Flatness

a. The “Moody Method” for flatness using the "Union Jack" pattern is accepted as a standard method. (See Tab 3 for documentation of the “Moody Method”) (1/13/11)

b. In order to avoid market confusion, scopes of accreditation that include surface plate – flatness only or surface plate – repeat reading or repeatability (only) shall indicate that only a “partial” calibration is offered. Consequently any corresponding endorsed calibration certificates shall also indicate that only a “partial” calibration was provided. (6/4/2015)

c. Typically the parameters reported for surface plate calibration are flatness and repeat reading. It should be noted that a repeat reading only measures the local variation in flatness (e.g. every five inches). However, it is acceptable to calibrate a surface plate for only the local variation in flatness if that is what has been agreed upon by the customer and it is documented during the contract negotiation process in compliance with ISO/IEC 17025:2005, Section 4.4. The repeat reading shall not be reported in a way that implies that overall flatness has been measured. (6/4/2015)

VI. Traceability of Environmental Chambers (see Tab 4 for Proposal: Consensus on Calibration of an Environmental Chamber) (5/5/2011)

a. That three approaches are deemed as acceptably meeting *P102 – A2LA Policy on Metrological Traceability* for environmental chambers*:*

1. An in-house calibration performed in accordance with the manufacturer instructions/recommendations and (T9) of P102, as long as the CAB, when using the environmental chamber, includes an accredited sensor with the load to measure the environment during the test; or

2. The CAB obtains an accredited calibration of the entire system; or

3. The CAB obtains an accredited calibration of the individual components of the entire system.

VII. Calibration of HE-NE lasers (02/04/2016)

The calibration of the vacuum wavelength of commercial He-Ne lasers used in normal*, routine measurements is not required based on international recommendations (see references 1, 2 and 3). Rather the following values are accepted:

$f(\text{He-Ne}_{\text{unstabilized}}) = 473.6127$ THz

and since $\lambda = c/f$ with the speed of light in vacuum fixed at c = 299 792 458 m/s, we have the corresponding wavelength of

$\lambda(\text{He-Ne}_{\text{unstabilized}}) = 632.9908$ nm

with relative uncertainty of

$u = 3.0 \times 10^{-6}$ (k=2).

For calibration work requiring more refined uncertainties and justifications the user is encouraged to seek traceable, stabilized calibrations through the appropriate National Metrology Institute or appropriate accredited source.

Note: this only applies to the vacuum wavelength and does not address the typical and necessary accessories of the common commercial laser system, e.g. sensors for measuring temperature, humidity, and pressure, and the associated optics. See ASME B89.1.8-2011.

*Normal environmental conditions are limited to the following:
Operating Temperature: (- 20 to + 50) °C
Non-operating Temperatures: (- 40 to + 80) °C
Relative Humidity: < 80 % RH
Operating Altitude: up to 3000 m
Non-operating Altitude**: up to 6000 m
Highest Shock: 15 g for 11 ms

**Limiting the non-operating altitude to 6000 m (≈18 000 feet) allows for most commercial flights.

References:

1. Note by BIPM, August 2012, “Recommended Values of the Standard Frequencies for Application Including the Practical Realization of the Metre and Secondary Representation of the Second” (Attached)

2. Jack A Stone, Measure (NCSLI), Vol. 4, No.3 (2009) 52-58, “Uncalibrated Helium Neon Lasers in length Metrology”.

3. J.A Stone, et al, Metrologia 46, (2009) 11-18, "Advice from the CCL on the use of unstabilized lasers as standards of wavelength: the helium-neon laser at 633 nm."

Document Revision History

Date	Description
6/4/2015	• Added items b and c to Section V. Surface Plate Flatness • Updated the reference to P102 • Added a new item "a" for section III on Fluke turn coils • Reordered old items "a" and "b" from section III on Fluke turn coils Revised old item "b" from section III on Fluke turn coils for change from (T9) to (T4) and for clarity (see TAB 2).
2/4/2016	• Added VII for He-Ne laser calibration traceability

A2LA Measurement Advisory Committee Meeting Minutes
The Sheraton Columbia Hotel
Columbia, MD

Saturday, March 11, 2006
(8:00 AM– 3:00 PM)

Summary

Agenda Item 6d: Uncertainty and statements of compliance (T. Rasinski)

Discussion: (See attachment 3) Under contract review there are often problems including guard banding, but a part of contract review is to have a guard banding policy and how the laboratory or customer has approved it. In many instances the customers are the one who are determining what the guard banding is.

Calibration providers cannot dictate to the client what will be done. If laboratories do not define the limitation then anything may be acceptable. Laboratories have to have a record or mechanism to extract this information.

A2LA is looking for a recommendation to determine how to approach this issue.

Motion 20: **Motion to recommend to Criteria Council that A2LA deal with statements of conformance and uncertainty as a contract review issue which is sufficiently addressed by existing requirements and take actions to educate labs on this issue.**

Motion 20 passed**: against - 1**

A2LA Measurement Advisory Committee Meeting
The Sheraton Columbia Hotel
Columbia, MD

Saturday, March 24, 2007

SUMMARY

An OEM in attendance requested guidance regarding pass/fail criteria in relation to listing this on issued calibration certificates. In his particular case as a manufacturer, the criteria are proprietary information. In reports issued by his laboratory, the customer is provided with the data, the uncertainty, and a pass/fail decision. During the discussion, it was thought that the OEM did not have to tell a laboratory whether or not their instrument passed; however, if pass/fail is listed on the calibration certificate, the OEM is then required to provide their decision rules. The OEM does not have to make a statement of compliance. Production tolerances are proprietary, when a calibration is performed and the equipment meets specifications, it can be stated that the item meets specification and this would meet the requirements in ISO/IEC 17025.

It was pointed out that the A2LA Calibration Program does require accredited laboratories to have the decision rule defined. A laboratory can state that the statement on the certificate indicating that the measurement uncertainty is considered should suffice. It was also discussed that the internal decisions are irrelevant if the laboratory only wants to know, “Can I use this specification?”

The consensus was that no decision rules need to be provided if the provider (OEM) states the measured value, the uncertainty, and that it is within specifications.

A2LA Measurement Advisory Committee Meeting
The Sheraton Columbia Hotel
Columbia, MD

Saturday, March 24, 2007

SUMMARY

g. The Fluke 50 Turn Coil was discussed. In many cases, the Fluke 50 turn coil is calibrated once and only once as long as they are not damaged. The problem is that no one is currently accredited to perform the calibration. If the calibration was performed many years ago, the laboratory may not be able to obtain the traceability information from the OEM. The concern is whether or not A2LA should require the laboratory to obtain another calibration on the coil in order to achieve traceability.

Based on discussions, an open-ended calibration interval is acceptable as further calibrations would not be needed, only visual checks. Further discussion with A2LA management will be required regarding the traceability of the initial calibration.

Measurement Advisory Committee Meeting Summary
The Sheraton Columbia Hotel
Columbia, MD

Saturday, April 12, 2008
(08:00 AM – 5:00 PM)

Meeting Minutes

e. Previous Action Item: D. Leaman to discuss with A2LA management further guidance on traceability for the valid calibration on the coils.

D. Leaman indicated that there are no issues regarding traceability for these items because we have worked with Fluke to get their traceability documents. Since we have this on file now this is not an issue for most of our labs.

The MAC discussed how this is still a non-accredited calibration and it was noted that A2LA staff is aware of this but since we do have the traceability information from Fluke this is not a concern because the laboratories are able to meet our traceability requirements through the reverse traceability process. The concern was how to handle those laboratories whose calibration certificates pre-date the information provided by Fluke to A2LA.The MAC also discussed that the coils are stable and there is no reason to require a recalibration unless the laboratory cannot establish traceability (i.e. the laboratory has lost the certificates for the item).

MOTION 8 –**To allow the laboratory to meet section T9 of the A2LA Traceability policy in lieu of the calibration certificate for cases where the calibration certificate pre-dates the information provided from Fluke.** ***Approved***.

Amendment to Motion 8 – **To amend the motion to indicate when conducting an in-house calibration it should be limited to the range from the initial original calibration certificate for the coil.** ***Approved***

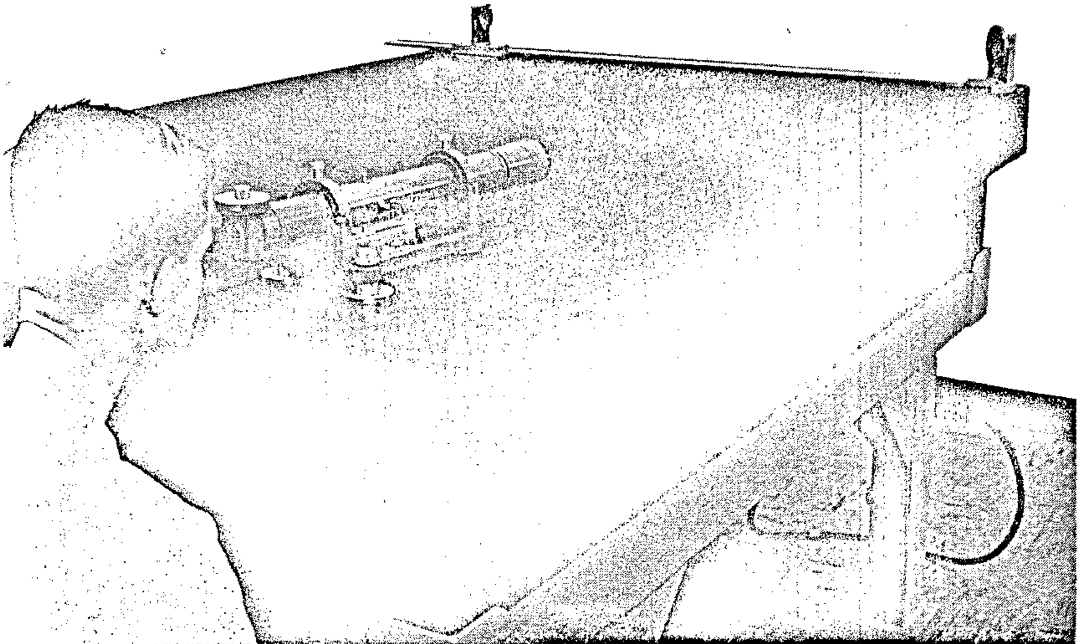


Fig. 1. Typical calibration setup showing the autocollimator, optical flat attached to mount on extreme left-hand corner, mirror mount on extreme right-hand corner and straight edge on end of surface plate.

how to calibrate surface plates in the plant

By J. C. Moody

Physical and Electrical Standards Dept.
Sandia Corp.
Albuquerque, N. M.

SINCE MEASUREMENTS are no more reliable than the surface plate on which they are referenced, it is important to know exactly the accuracy of the plate being used. Surface plates are manufactured to accuracies varying from 0.002 to 0.00005 inch of deviation from a true plane. The user should check each plate after it is installed to determine whether it meets specifications and from time to time thereafter to learn the effect of wear and environment. The check measurements must, for practical purposes, be done in the work environment.

Fortunately, a practicable method of accurately calibrating surface plates is available to industry. The method used in the metrology laboratory at Sandia Corp. is highly accurate yet can be performed by semiskilled personnel using instruments available to any industrial laboratory. This method is an application and extension of procedures developed by K. J. Hume (British metrologist) and involves no new principles.

Ideally, the calibration should be performed in a room in which the temperature of the plate can be kept in equilibrium and from which thermal currents can be excluded. However, industry uses

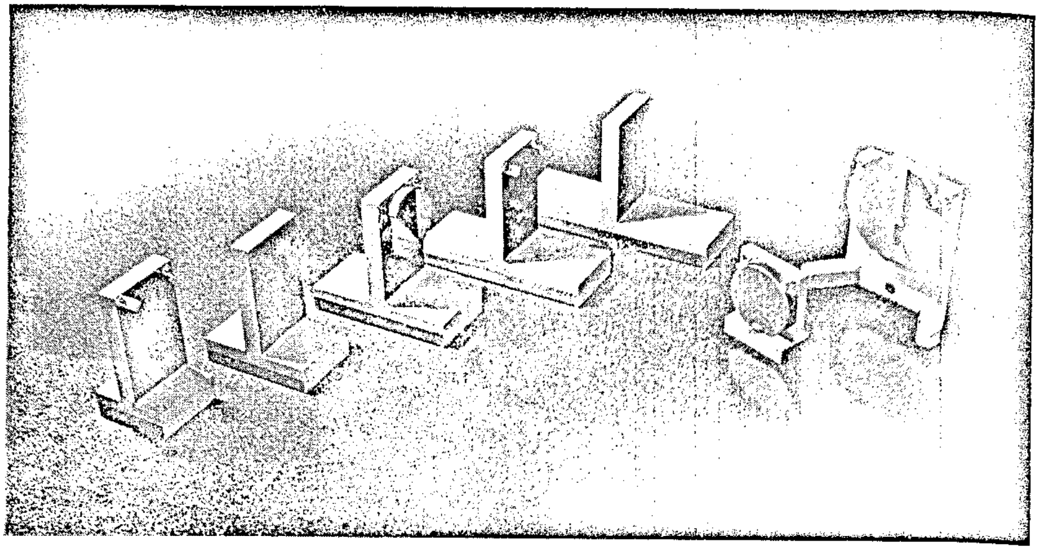


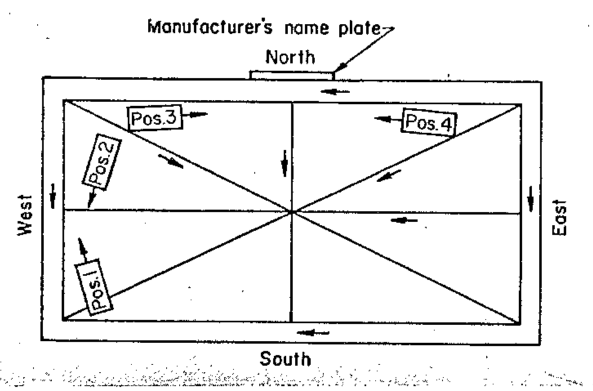
Fig. 2. Mirror mount, reflector mounts and optical flats used for calibrating surface plates.

surface plates under conditions that are less than ideal. These plates can be satisfactorily calibrated under the same conditions. Extremes of temperature changes, thermal currents, and vibration are obviously to be avoided.

Calibration Method: Equipment needed for this method is shown in *Fig.* 1. The autocollimator is essentially an optical lens system from which parallel rays are emitted. These rays strike the surface of a steel optical flat and are reflected back into the autocollimator. The reflected rays produce an image at the focal plane of the autocollimator from which angular displacements can be accurately determined.

The reflector is mounted on a bracket, the support pads of which are separated by a distance

Fig. 3. Positions of autocollimator during readings for the eight principal lines.

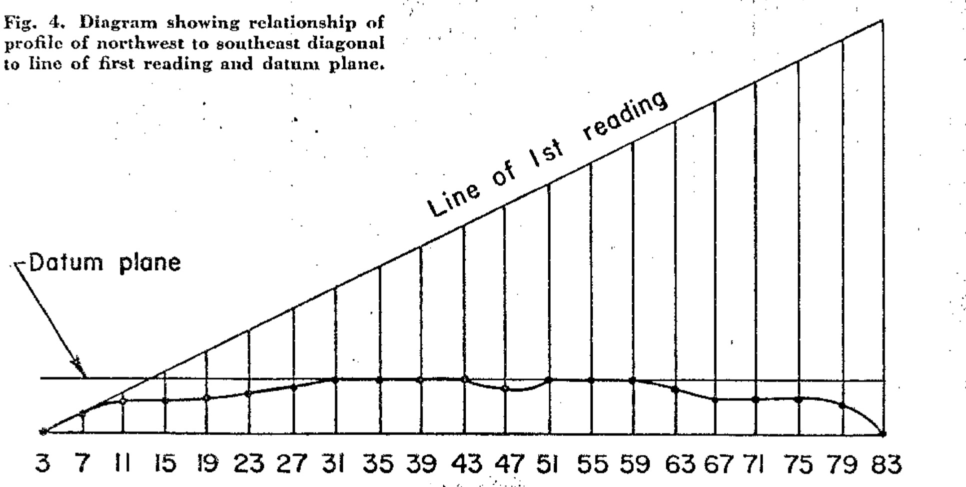


arbitrarily chosen so that it will divide evenly into the dimensions of the surface plate. This distance should be about 8 percent of the length of the short side of the plate. Various reflector mounts needed for different size plates are shown in *Fig.* 2. The mirror mounting bracket is so designed that the mirror mounting is normal to the surface plate. Steel optical flats, the faces of which do not deviate from a plane by more than 0.000003 inch, are used for both the mirror and reflector. In addition, a straight edge, graduated in increments equal to the distance between the support pads of the reflector stand, is used.

A total of eight lines of readings are taken: four perimeter lines, two diagonal lines, and two center lines, *Fig.* 3. The perimeter lines are laid out one increment from the edge of the plate. The precise stations at which readings along all eight lines are taken are measured off in steps equal to the increments on the straight edge. Many more readings could be taken, but a reasonable compromise between accuracy and economy is achieved by this method.

Detailed instructions for using an autocollimator are supplied with the instrument and should be studied carefully. The position of the autocollimator for each line of readings is shown in *Fig.* 3. The readings along the north perimeter line, for example, are taken with the autocollimator in the southwest corner of the plate. The reflector is moved along the line and readings are taken at each station. These readings are entered directly on the properly identified work sheet, *Fig.* 4. After each line is completed, the reflector is moved back to the first station on that line and another reading taken. If this does not agree within ± 0.3 sec. of

Fig. 4. Diagram showing relationship of profile of northwest to southeast diagonal to line of first reading and datum plane.



arc with the first reading taken at the same station, the operation must be repeated.

Autocollimator readings entered on the work sheet show only angular displacement in tenths of a second of arc in relation to the line of first reading. To be readily meaningful, these must be converted to linear deviations from a base plane. The procedure for these conversions and their presentation will be discussed in the following paragraphs.

Though care must be exercised in each step, the conversion is not a formidable task. Readings can be made in about two hours; an intelligent, properly instructed clerk can reduce the data to an accurate profile of the surface plate in an equal time.

Simplified Data Conversion Procedure: Directions for converting autocollimator readings into linear displacement in hundred-thousandths of an inch are given without any attempt at theoretical justification. One line of each class will be explained in detail. The reader who is interested in the theoretical considerations should read K. J. Hume's *Engineering Metrology* or the author's paper, *The Metrology of Surface Plates*, copies of which are available upon request.

The person who is to reduce the data is given a work sheet for each of the eight lines, TABLE 1. On these, the stations at which readings were taken are indicated in Column 1 in terms of inches from the edge of the plate in the direction in which the line was read. The autocollimator readings are entered in Column 2. No reading is entered for the first station on the line.

CONVERSION FOR DIAGONALS: To process the Northwest to Southeast diagonal line data, the following steps should be taken in order:

1. Convert the autocollimator readings into angular displacement by determining the amount by which each value in Column 2 is greater or less than the first value in Column 2. Do this at each station; enter the result in Column 3, paying attention to the sign.
2. Next, determine the algebraic sum of the angular displacement at each station and enter this value in Column 4. To do this, add the values in Column 3 down to and including each station.
3. Divide the last value in Column 4 by the total number minus one of the stations on the line to determine the correction factor. (In the example shown there are 21 stations. Hence, —280/20 = —14.)
4. Set up an arithmetic progression in Column 5. Reverse the sign of the value in Column 4 opposite the midstation and enter it opposite the same station in Column 5. Working up Column 5 from the midstation, add the correction factor cumulatively at each station. Return to the midstation and subtract the correction factor cumulatively at each station to the bottom of the column. The resulting arithmetical progression is the cumulative correction factor for each station.
5. At each station, add algebraically the values in Columns 4 and 5. Enter the sum which is the angular displacement from the datum plane in Column 6. (The datum plane, *Fig.* 4, is that plane in which the center point of the surface plate lies and is parallel to the lines containing the end points of each diagonal.) Proceed with the other diagonal in exactly the same way to this point. Before the last two columns for the diagonal can be completed, computations for the perimeter and center lines must be carried to this point. Do the perimeter lines next.

CONVERSION FOR NORTH PERIMETER LINE:

1. Proceed exactly as with the diagonals through Column 4 for each of the perimeter lines.
2. Prepare a chart of the surface plate as illustrated in *Fig.* 5. Enter the physical center, 0, and the values found for the ends of the diagonals from

Table 1—Work Sheets for Calibrating a 48 x 78-Inch Surface Plate*

1	2	3	4	5	6	7	8
Station (inches from edge) (No.)	Auto-collimator Readings (0.1″ arc)	Angular Displacements (0.1″ arc)	Sum of Displacements (0.1″ arc)	Cumulative Correction Factor (0.1″ arc)	Displacement from Datum Plane (0.1″ arc)	Displacement from Base Plane (0.1″ arc)	Displacement from Base Plane (0.00001 in.)
Diagonal, Northwest to Southeast							
3	—	—	—	−36	−36	32	6
7	65	0	0	−22	−22	46	9
11	60	−5	−5	−8	−13	55	11
15	50	−15	−20	+6	−14	54	11
19	52	−13	−33	+20	−13	55	11
23	55	−10	−43	+34	−9	59	12
27	56	−9	−52	+48	−4	64	13
31	55	−10	−62	+62	0	68	14
35	50	−15	−77	+76	−1	67	14
39	55	−10	−87	+90	+3	71	14
43	48	−17	−104	+104	0	68	14
47	50	−15	−119	+118	−1	67	13
51	52	−13	−132	+132	0	68	14
55	53	−12	−144	+146	+2	70	14
59	49	−16	−160	+160	0	68	14
63	46	−19	−179	+174	−5	63	13
67	42	−23	−202	+188	−14	54	11
71	53	−12	−214	+202	−12	56	11
75	49	−16	−230	+216	−14	54	11
79	45	−20	−250	+230	−20	48	10
83	35	−30	−280	+244	−36	32	6
Diagonal, Northeast to Southwest							
3	—	—	—	−53	−53	15	3
7	66	0	0	−35	−35	33	6
11	54	−12	−12	−18	−30	38	7
15	54	−12	−24	0	−24	44	8
19	52	−14	−38	+17	−21	47	9
23	55	−11	−49	+35	−14	54	11
27	57	−9	−58	+53	−5	63	12
31	50	−16	−74	+70	−4	64	13
35	50	−16	−90	+88	−2	66	13
39	54	−12	−102	+105	+3	71	14
43	45	−21	−123	+123	0	68	14
47	44	−22	−145	+141	−4	64	13
51	45	−21	−166	+158	−8	60	12
55	45	−21	−187	+176	−11	57	11
59	48	−18	−205	+193	−12	56	11
63	42	−24	−229	+211	−18	50	10
67	42	−24	−253	+229	−24	44	9
71	42	−24	−277	+246	−31	37	8
75	48	−18	−295	+264	−31	37	7
79	42	−23	−318	+281	−37	31	6
83	32	−34	−352	+299	−53	15	3
North Perimeter Line East to West							
4	—	—	—	−53	−53	15	3
8	205	0	0	−40	−40	28	6
12	197	−8	−8	−26	−34	34	7
16	205	0	−8	−13	−21	47	9
20	203	−2	−10	+1	−9	59	12
24	202	−3	−13	+14	+1	69	14
28	199	−6	−19	+28	+9	77	15
32	190	−15	−34	+41	+7	75	15
36	195	−10	−44	+55	+11	79	16
40	183	−17	−61	+69	+8	76	15
44	186	−19	−80	+82	+2	70	14
48	187	−18	−98	+96	−2	66	13
52	186	−19	−117	+109	−8	60	12
56	184	−21	−138	+123	−15	53	11
60	185	−20	−158	+136	−22	46	9
64	190	−15	−173	+150	−23	45	9
68	179	−26	−199	+163	−36	32	6
East Perimeter Line North to South							
4	—	—	—	−53	−53	15	3
8	35	0	0	−49	−49	19	4
12	21	−14	−14	−45	−60	8	2
16	25	−10	−24	−41	−65	3	1
20	28	−7	−31	−37	−68	0	0
24	34	−1	−32	−33	−65	3	1
28	32	−3	−35	−29	−64	4	1
32	35	0	−35	−25	−60	8	2
36	40	+5	−30	−21	−51	17	3
40	42	+7	−23	−17	−40	28	5
44	35	0	−23	−13	−36	32	6

*All values except Columns 1 & 8 are in tenths of a second of arc.

Table 1 (Continued)*

1	2	3	4	5	6	6a	7	8
Station (inches from edge) (No.)	Auto-collimator. Readings (0.1″ arc)	Angular Displace-ments (0.1″ arc)	Sum of Displace-ments (0.1″ arc)	Cumulative Correction Factor (0.1″ arc)	Displace-ment from Datum Plane (0.1″ arc)		Displace-ment from Base Plane (0.1″ arc)	Displace-ment from Base Plane (0.00001 in.)
South Perimeter Line East to West								
4	—	—	—	— 36	—36		32	6
8	164	0	0	— 18	—18		50	10
12	150	—14	— 14	0	—14		54	11
16	156	— 8	— 22	+ 19	— 3		65	13
20	155	— 9	— 31	+ 37	+ 6		74	15
24	151	—13	— 44	+ 55	+11		79	16
28	153	—11	— 55	+ 73	+18		86	17
32	151	—13	— 68	+ 92	+24		92	18
36	146	—18	— 86	+110	+24		92	18
40	140	—24	—110	+128	+18		86	17
44	135	—29	—139	+147	+ 8		76	15
48	135	—29	—168	+165	— 3		65	13
52	133	—31	—199	+183	—16		52	11
56	133	—31	—230	+201	—29		39	8
60	134	—30	—260	+220	—40		28	6
64	140	—24	—284	+238	—46		22	4
68	139	—25	—309	+256	—53		15	3
West Perimeter Line North to South								
4	—	—	—	—36	—36		32	6
8	60	0	0	—30	—30		38	4
12	46	—14	—14	—24	—38		30	6
16	45	—15	—29	—17	—46		22	4
20	47	—13	—42	—11	—53		15	3
24	50	—10	—52	— 5	—57		11	2
28	45	—15	—67	+ 1	—66		2	0
32	59	— 1	—68	+ 7	—61		7	1
36	60	0	—68	+14	—54		14	3
40	60	0	—68	+20	—48		20	4
44	49	—11	—79	+26	—53		15	3
Center Line East to West								
4	—	—	—	—65	—65	—58	10	2
8	117	0	0	—59	—59	—52	16	3
12	124	+ 7	+ 7	—53	—46	—39	29	6
16	121	+ 4	+11	—47	—36	—29	39	8
20	125	+ 8	+19	—42	—23	—16	52	10
24	120	+ 3	+22	—36	—14	— 7	61	12
28	115	— 2	+20	—31	—11	— 4	64	13
32	115	— 2	+18	—26	— 8	— 1	67	13
36	113	— 4	+14	—21	— 7	0	68	14
40	113	— 4	+10	—15	— 5	+ 2	70	14
44	103	—14	— 4	—10	—14	— 7	61	12
48	108	— 9	—13	— 4	—17	—10	58	12
52	103	—14	—27	+ 1	—26	—19	49	10
56	100	—17	—44	+ 7	—37	—30	38	8
60	107	—10	—54	+12	—42	—35	33	7
64	104	—13	—67	+18	—49	—42	26	5
68	104	—13	—80	+23	—57	—50	18	3
Center Line North to South								
4	—	—	—	+11	+11		79	16
8	66	0	0	+10	+10		78	16
12	64	—2	— 2	+ 9	+ 7		75	15
16	63	—3	— 5	+ 8	+ 3		71	14
20	65	—1	— 6	+ 7	+ 1		69	14
24	66	0	— 6	+ 6	0		68	14
28	69	+3	— 3	+ 5	+ 2		70	14
32	75	+9	+ 6	+ 4	+10		78	16
36	74	+8	+14	+ 3	+17		85	17
40	71	+5	+19	+ 2	+21		89	18
44	70	+4	+23	+ 1	+24		92	18

*All values except Columns 1 & 8 are in tenths of a second of arc.

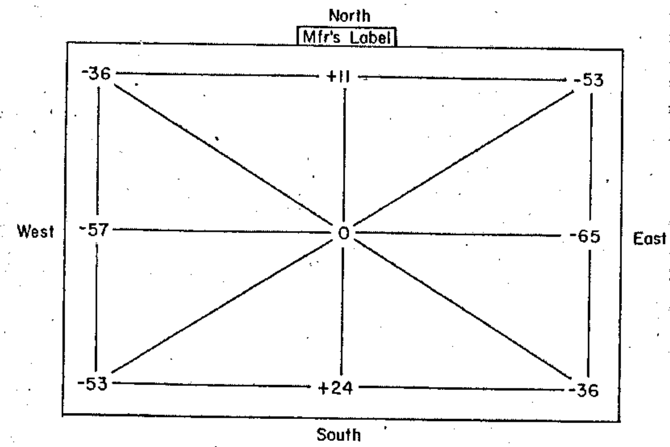


Fig. 5. Data reduction work sketch for determining correction factors and displacements from datum plane.

Column 6 in the work sheets as shown. This chart is important as without it there is danger of confusing the figures.

3. Enter the value for the NE end of the NE-SW diagonal in Columns 5 and 6 opposite the first station. Enter the value of the NW end of the NW-SE diagonal opposite the last station in Column 6 only.
4. Next, find the correction factor. Subtract the value opposite the last station in Column 4 from the value opposite the same station in Column 6 [—36 —(—199) = 163]. Enter this value opposite the last station in Column 5. Subtract this value from that opposite the first station in Column 5 (—53 —163 = —216) and divide the result by the total number of stations on the line minus one (—216/16 = —13.5). The result is the correction factor.
5. Beginning at the last station in Column 5, add the correction factor cumulatively up the column at each station. (Since the correction factor in the example is —13.5 to avoid decimals —13 and —14 are used alternately.)
6. To find the angular displacement from the datum plane, algebraically add the values opposite each station in Columns 4 and 5 and enter the results in Column 6.

   Complete the conversion for each of the perimeter lines to this point and enter the values at the midpoints in *Fig.* 5. Now proceed with the center lines.

Conversion for East to West Center Line:

1. Carry the conversion through Column 4. The procedure for the center lines is exactly the same as for the diagonal and perimeter lines to this point.
2. From *Fig.* 5, enter the value for the midpoint of the east perimeter line opposite the first station in Columns 5 and 6. Enter the value for the midpoint of the west perimeter line opposite the last station in Column 6 only.
3. Subtract the value opposite the last station in Column 4 from the value opposite the same station in Column 6 and enter this value at the last station in Column 5.
4. Subtract the last value in Column 5 from the first and divide the result by the total number of stations on the line minus one. The result is the correction factor.
5. Beginning at the last station in Column 5, add the correction factor up the Column in an arithmetic progression to find the cumulative correction factor for each station.
6. At each station, algebraically add the values in Columns 4 and 5 and enter the result in Column 6. This is the angular displacement from the datum plane.
7. Change the sign of the value opposite the midstation in Column 6 and add it to the value opposite each station in Column 6. Enter the sums in Column 6a.

A word of explanation is necessary at this point. The center line check is the criterion of accuracy for the entire operation. The value at the point at which the center lines and diagonals intersect is physically zero. If everything were done perfectly, the value opposite the center station would be zero. But this is not possible because each slight error in reading the instrument is reflected at the midstation of the center lines. If the magnitude of this error is under 0.0001, the calibration may be regarded as satisfactory; if not, the job must be done over.

Column 6a, which appears only in the work sheets for the center lines, is used to move the error away from the center, which is known to be zero, out to the perimeter.

Final Steps in Conversion: The work sheets for the eight lines are now completed through Column 6, including Column 6a for the center lines. The procedure for Columns 7 and 8 is identical for all work sheets and must be done together.

1. Seach through Column 6 for all work sheets, Column 6a of the center lines, for the lowest value in all of the 8 columns. Add this value to the value opposite each station in Column 6 (6a for the center lines) and enter the sums in Column 7. This

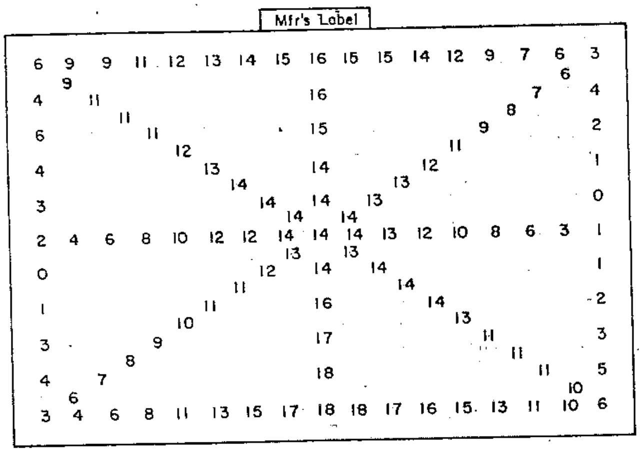


Fig. 6. Linear deviations from base plane indicated along the eight principal lines of a 48 x 72-inch granite surface plate. Figures represent height from base plane in 0.00001 inch units. All points lie between two parallel planes 0.00018 inch apart.

figure is the displacement from the true base plane. This is defined as that plane containing the point of lowest reading and parallel to the datum plane.

2. Next, convert the values in Column 7 to linear values in 0.00001 inch. To do this, multiply the product of the sine of 1 second (0.000005) times the distance between the center lines of the mirror mounts (4 inches in the example) (0.000005 × 4 = 0.00002) by the values in Column 7 at each station. Since the values in Column 7 are in tenths of a second of arc, it is necessary to divide the product at each station by 10 to get the decimal point in the right place. Round out the answer to the nearest hundred-thousandth of an inch, drop out the decimal point, and enter the value in Column 8.

Conclusion: The data from Column 8, when reported on the form shown in *Fig.* 6, allows the user to see at a glance the features of the surface plate he is using. It shows not only the extremes of variation, but also the best areas on the plate.

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Cold Rolling 'Builds In' Longer Life in Backup

By cold rolling fillets between the neck and roll body of backup rolls, tensile strength at the point of most common failure was increased automatically and life of the rolls was substantially lengthened. The technique was devised at the Roll Div. of Blaw-Knox Co. where, as a result of fatigue, a hairline crack in the fillet at or near the surface has consistently shortened roll life. Because of the geometric proportions of the rolls, there is greater stress concentration at the fillet accounting for the need for special working at that point. Fatigue limits, which are approximately one-half of tensile strength, increased proportionately with the utilization of cold rolling.

The cold rolling tool used in the technique developed at Blaw-Knox consists of a wheel, positioning apparatus and a gage to provide a constant register of the amount of pressure applied to the metal being rolled.

Proposal: Consensus on Calibration of an Environmental Chamber
Pam Wright
11/15/2010

Background:

A deficiency was written for a Conformance Assessment Body (CAB) because a testing laboratory did not have their thermocouple calibrated within their environmental chamber. The laboratory just had the controller calibrated by electrical simulation as part of their (T9) internal calibration. The assessor and the lab disagreed on the issue and the issue eventually went to the Measurement Advisory Committee (MAC) for voting. The MAC voted that it was not acceptable to calibrate the controller only and that the thermocouple needed to be calibrated or the chamber needed to be mapped. The decision of the MAC was presented to the Materials Testing Advisory Committee (MTAC) and they agreed by a majority with the decision made by the MAC. Staff brought up a concern that this decision by the MAC and MTAC would put an undue burden on our CABs as one had expressed during their initial assessment that if they were required to calibrate the thermocouples in all their environmental chambers, they would stop the assessment and elect not be accredited by A2LA. Several others CABs expressed concern over the burden this would cause when even the Original Equipment Manufacturer (OEM) did not calibrate the thermocouple upon the completion of the manufacturing process. Management agreed that we did not want to put an undue burden on our CABs beyond that of other equivalent Accrediting Bodies (ABs) and tasked the Calibration Accreditation Manager (AM) with investigating this matter further. It should be noted that the Calibration AM contacted several international peers regarding this matter and received little to no response.

The Calibration Senior Accreditation Officer (SrAcO) was tasked with contacting several OEMs, both accredited and non-accredited to determine whether or not they actually calibrate the thermocouples as part of the calibration provided with the chamber. The SrAcO discussed the calibration process with both accredited and non-accredited OEMs and upon discussion with the manufacturers it was discovered that none of them calibrate the thermocouple after manufacturing a new chamber, rather, they only calibrate the controller. Almost all the OEMs noted that upon special request they will calibrate the thermocouple and map (multipoint calibration of the entire chamber) the chamber. One OEM did state that they actually do not like to map the chamber as they would be mapping an empty chamber and once the user puts a load into the chamber that the mapping of that empty chamber is invalid as the characteristics and behaviors of the chamber is changed when putting a load in. From these discussions it appears that the consensus of the MAC/MTAC to calibrate the thermocouple would be going above and beyond what the manufacturers are doing when they calibrate their new chambers.

In conducting a review of guidance documents available on this matter a Euramet document *Calibration of Climatic Chambers Requirements for the Accreditation of Calibration Laboratories* was consulted which describes the guidance laid out by the EU for their Accreditation Bodies for the accredited calibration of climatic chambers. In this document it was acknowledged that calibration of a climatic chamber is not the best method for documenting the environmental condition during operation, rather, the use of at least one sensor for temperature and/or humidity in close proximity with the load will provide much more reliable data. It was also recommended that calibration providers inform their customer of this fact. Furthermore, it was acknowledged that customers in many cases “want a calibration certificate as cheap as possible” and they ask for a “one-point-calibration” typically in the center of an empty climatic chamber. The document goes on to explain while this approach does not make much sense and that it is not a “calibration” it acknowledges that it is difficult to refuse an accreditation for such a service.

This entire issue was then discussed at the management level in order to develop a policy that allows for the integrity of the test to be preserved while also ensuring that A2LA does not place an undue burden on our CABs beyond that of other ABs.

Conclusion:

It was determined that a calibration performed in accordance with the manufacturer instructions/recommendations of an environmental chamber, whether an accredited external or (T9) internal calibration, is deemed an acceptable calibration as long as the CAB, when using the environmental chamber, includes an accredited sensor with the load to measure the environment during the test.